The Thesis Committee for Sandra Milena Wiegand
Certifies that this is the approved version of the following thesis:

An Analysis to the Main Economic Drivers for Offshore Wells Abandonment and Facilities Decommissioning

APPROVED BY
SUPERVISING COMMITTEE:

Supervisor:

Steve Nichols

Manas Gupta

An Analysis to the Main Economic Drivers for Offshore Wells Abandonment and Facilities Decommissioning

by

Sandra Milena Wiegand, B.S.

Thesis

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Master of Science in Engineering

The University of Texas at Austin

August 2011

Dedication

This thesis is dedicated to the two most important people in my life: my wonderful father, Hugo Torres and my dear husband, Michael Wiegand. To my father who taught me the meaning of unconditional love. Thank you for giving me the best you had and helping me succeed in life and instilling in me the confidence that I am capable of doing anything I put my mind to. I love you Daddy !. And to my husband, my soul mate and confidant, for always being there for me. Thank you for you endless love, support and patience as I went through this journey. I could not have made it through without you by my side.

Acknowledgements

I would like to express my gratitude to the following people:

Dr. Robert Duvic, for his guidance throughout the first stage of my thesis process.

To Dr. Farid Shecaira and Mr. Dalmo Barros for all their support as my managers during these last two years.

To Mr. Manas Gupta for his contribution as the co-supervisor for this thesis.

To Ms. Solimar Rojas for her support and friendship.

To Ms. Ingrid Sellick for her valuable ideas and all the wonderful time we shared during the two years in the master's program.

To Mr. Don Porteous for all his time, support and guidance.

To Mr. Joseph Ayyoubi for sharing all his decommissioning knowledge and experience with me, his input was very much appreciated during the elaboration of this thesis.

Abstract

An Analysis to the Main Economic Drivers for Offshore Wells Abandonment and Facilities Decommissioning

Sandra Milena Wiegand, M.S.E.

The University of Texas at Austin, 2011

Supervisor: Steve Nichols

Decommissioning and abandonment is a relevant issue in the petroleum industry because of the complex operations involved and the results after the decision has been made. Several factors could lead to abandoning wells and decommissioning platforms, among others hurricanes, production decline, economic limit, etc. Decommissioning and abandonment operations have a great impact in the revenue stream which is either lost or temporarily deferred depending on the situation. Every year between 100-150 platforms are decommissioned and approximately 620 wells are abandoned in the Gulf of Mexico. A case-by-case scenario should be revised on an annual basis and all the possible options to be considered and submitted to the Government. This thesis presents an overview of the topic and an analysis on when decommissioning and abandoning alternatives are recommended for the optimization of the economical resources.

Table of Contents

List of Figures

List of Illustrations

Chapter 1: Introduction

Decommissioning could be defined as a multidisciplinary process of deciding which one is the best way is to shut down production and operations for a facility once the field has reached its economic life. Its main objective is to deliver all property free from hazards for the environment and to restore the area to the original conditions, as per the applicable regulations and company expectations.

Decommissioning involves a long term planning and covers several phases and areas. Its phases are closing, plugging and abandoning the well(s) and pipelines, cleaning the site, making the facilities and structural components safe, removing equipments, disposing, reusing or recycling them, and finally, providing monitoring and surveillance if needed. Among the areas for the planning are Health, Safety and Environmental (HSE), economic appraisals, legal provisions, technical issues, stakeholders' involvement, etc. Each platform or structure is different due to unique characteristics such as location, design and installation, and they are operated for specific purposes at a specific site, so a case-by-case evaluation is required. In general, decommissioning is followed through on a case-by-case basis where several factors are carefully analyzed in order to minimize risk to the personnel, environment and compliance with the government regulations.

Many multinational companies that work in the oil and gas sector have undertaken voluntary improvements to their environmental and social management practices in order to take a more comprehensively approach to manage their business risks throughout the project life cycle and comply with their own internal corporate social responsibility policies and principles. These efforts have contributed to a better analysis and mitigation of the anticipating effects expected from possible decommissioning alternatives.

Decommissioning and abandonment could be challenging issues not easy to predict because of mainly the following reasons: Nowadays, new technologies allow a more efficient and extensive oil and gas recovery so this fact prolongs the life of a field; the optimization of resources using new subsea systems that “tie back” to existing platforms add value to a project so an infrastructure life expectancy is prolonged; the volatility in the oil price determine whether it is economic or not to extract oil from a particular field.

Since oil production started in the Gulf of Mexico (GoM) in 1947, more than 6,500 platforms have been designed, built and installed on the continental shelves of more than 53 countries around the world (Thornton, 1997). The majority of these platforms are located in the United States GoM which is one of the largest oil and gas producers in the world. The GoM is part of the Outer Continental Shelf (OCS) which is the submerged Federal land off the United States coasts that supplies the Nation’s energy and non-energy mineral needs. The decommissioning market is forecast to be worth about US$3 billion over the next 5 years. (Decommissioning Activity in the Gulf of Mexico, 2009)

It is the operators and owners responsibility to supply government authorities with all the information about each possible decommissioning option and to recommend the best solution. The final decision on how the structure and wells are decommissioned is made by the government authorities.

The decommissioning phase is the stage least enjoyable for the operator/owner of the facilities and wells because means to face the abandonment and the end of the productive life of a project. Once the aging fields reach their production and economic limits the possibilities of well abandonments increase as well.

This project provides a general outlook of the many decommissioning related issues that impact the economical results for wells and facilities. The study is focus on scenarios that happen in the GoM and it will provide an insight about the impact of the abandonment cost in the decision making process.

1.1 Background

Since exploration and production began in the GoM, thousands of wells have been drilled in shallow, deep and ultra-deep waters. In general, the common water depth classification for projects in the GoM is as follows: Projects in less than 1,200 ft water depths are considered to be shallow-water, those in between 1,201 ft and 5,000 ft are considered to be deepwater projects and those in greater than 5,001 ft are ultra-deepwater projects. Illustration 1 shows the U.S. Gulf of Mexico overview.

As mentioned before, production started in the GoM in 1947 and the first decommissioning operation took place in 1973 (Griffin, 1998). Today, decommissioning frequency ranges from 100 to 150 installations per year (Watson, 1998) and over the past decade 424 wells have been plugged and abandoned (Decommissioning activity in the Gulf of Mexico, 2009). Approximately 6,976 platforms have been installed in the GoM, by 2010 and there are 3,817 active and 3,000 already removed from the GoM (BOEMRE, 2011).

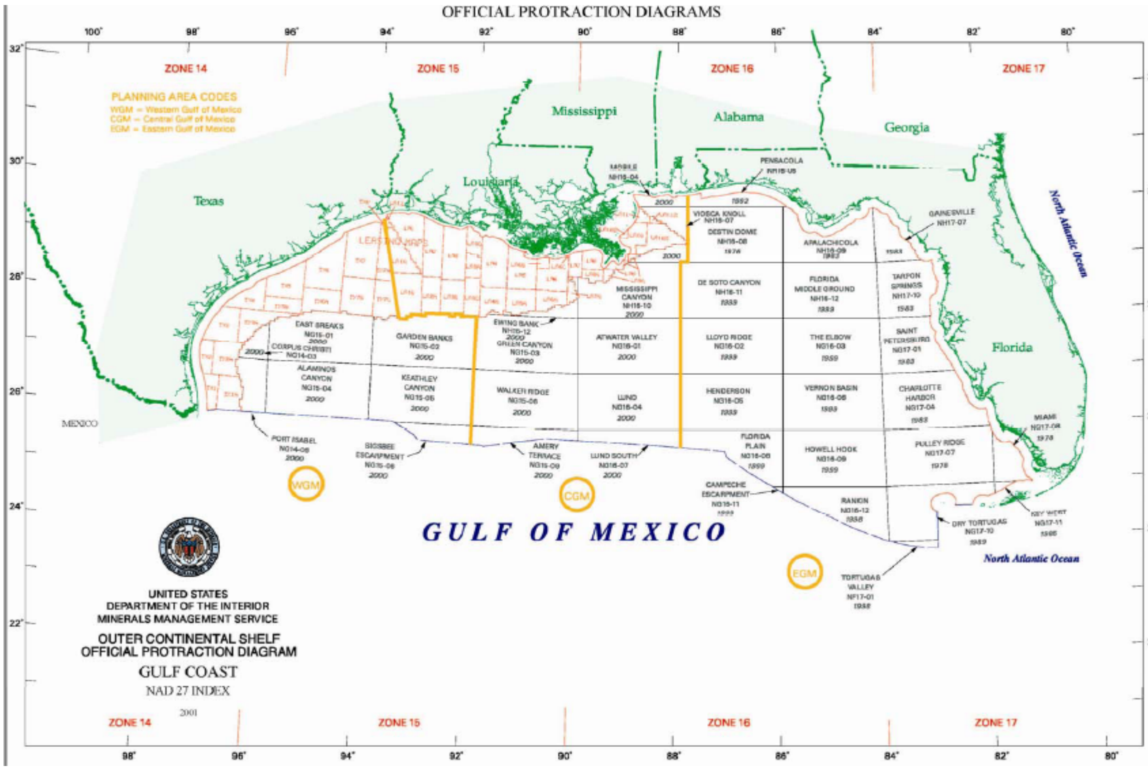

Illustration 1: Map of the Gulf of Mexico (Byrd, 2009)

The climatic conditions in the GoM play an important role to be considered during the decision making process for the decommissioning. Due to the high volume of oil and gas operations in the GoM and its weather exposure, this area is very vulnerable to a range of physical damage and destruction, business interruption and pollution liability. For example, during the Hurricanes Katrina and Rita, it has been reported that an additional 150-200 platforms were removed as a result of the aftermath of these hurricanes. The GoM has experienced 191 hurricanes since 1937 and 79 have passed over or close to offshore oil and gas structures (National Hurricane Center, 2011).

Illustration 2: Platforms damaged during Katrina Hurricane in 2005 (Oil Field Diving, 2000)

Figure 1 illustrates the damage caused by the stronger hurricanes in the last two decades. Therefore, the risk and cost involved in decommissioning destroyed structures is more expensive than conventional abandonment due to the stretch of resources and the time constrains during the recovery stage. Throw in the occasional devastating hurricane and the huge impact this has had both in activity volume and cost, it is estimated the annual industry worth between \$377M and \$825M. The total exposure for decommissioning in the Gulf of Mexico is between \$18bn and \$57bn, this big range is due to the unpredictability nature of the decommissioning activity (Decommissioning Activity in the Gulf of Mexico, 2009).

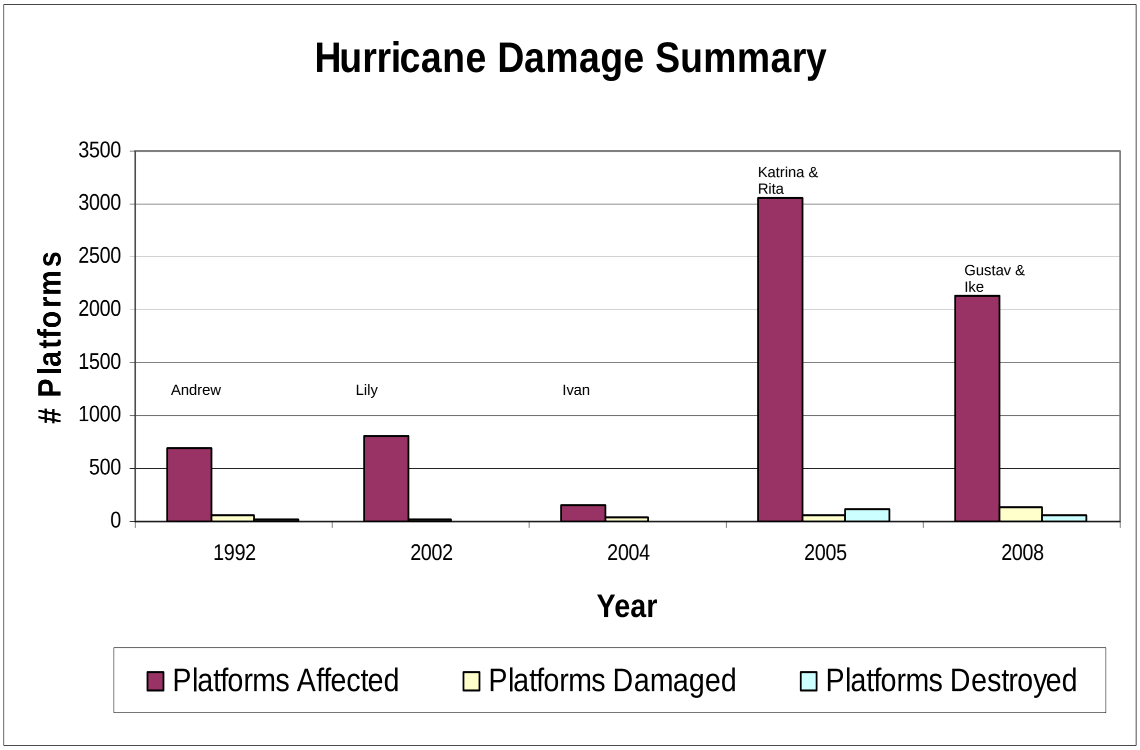

Figure 1: Hurricane Damage Summary in the GoM (National Hurricane Center, 2011)

The decommissioning process can be described in four different phases: Plugging and abandonment which is the process of plugging all exploration and development wells. This phase involves a careful analysis of the producing zones, isolating them and setting the proper concrete and plugs. Also, involves integrity tests and cleaning of the well site. Pipeline decommissioning which must be done in order to prevent leaks and safety hazards for the environment, navigation, and human lives. Platform decommissioning which is executed according to the location and design of the platform and should fully comply with the applicable laws. Site clearance is when all the obstructions are removed from the location. This process may require divers to search around the well bore, or seafloor scanning for verification of the clearance.

1.2 Motivation

Decommissioning and abandonment is a relevant topic in the oil and gas industry due to the large investment that these activities involve and the exposure with all stakeholders and government during the planning and execution phase. At the end of the productive life of a field the cash flow is affected and yearly update in the expenses and production forecast may affect the timing for the operations. Planning is important to properly reserve the resources needed for the implementation of the plans. During the lifetime of a field multiple scenarios may arise such as keeping production in a field or the sale of the field and/or facilities before the depletion of the hydrocarbons.

1.3 Scope of the study

This research is limited to cases in the GoM, in shallow waters and in deep waters. The information presented in this report could be used as a basic approach for a person that wants to know more about decommissioning and the different factors that affect the economics of that kind of projects. The results are solely applied for the gas and oil industry and as decommissioning and abandonment are a case-by-case situation, the objective is to illustrate a methodology that could be applied for future cases. Data for economical analysis was sensitive to confidentiality so a more detailed economical analysis is not presented.

1.4 Objectives

The objectives of this study are to provide an insight into the literature and common practices in the industry for decommissioning, abandonment and to assess the impact of the key drivers in the decommissioning job cost. But in order to achieve these objectives is important to take in consideration the limitations and opportunities during the planning of the jobs and their economical analysis. Relevant issues are examined and it was analyzed how they affect the economical context of the different decommissioning methods including the well plug and abandonment issues, using current available technology. The following are the specific objectives:

1. Define and identify the main options available for decommissioning platforms and wells abandonment in the GoM.

2. Evaluate the risk issues for the various decommissioning options and well abandonment; identifying in the process key points to deal with similar situations.

3. Provide an overview of the current status and the market opportunity for the decommissioning field.

1.5 Methodology

In order to accomplish with the objectives set for this study a methodology was established. At first, the objectives and scope of work were identified and formulated. Then literature review and industry cases were analyzed, this was helpful on the path to pursue later. With the knowledge acquired from the literature reviewed and the economic engineering class all information was examined under different scenarios. Finally, the conclusions and recommendation for future cases were summarized and presented.

Chapter 2: Literature Review

2.1 Regulatory Framework

By their very nature, resource extraction activities, in the oil and gas and mining sectors in particular, have the potential to generate negative environmental, social, health and safety impacts. Many of these impacts endure after the conclusion of commercial exploitation. If not properly addressed and mitigated, these impacts can result in significant legal and financial burdens to the operator(s), the local population, and the host countries once exploitation ends (World Bank Multistakeholder Initiative, 2010).

The U.S. Department of Interior (USDOI) and the U.S. Bureau of Ocean Energy Management Regulation and Enforcement (BOEMRE) (Formerly Minerals Management Service (MMS)), are responsible for leasing the submerged Federal lands on the United States OCS for minerals exploration, development, and production under the OCS Lands Act Amendments of 1978. To meet this responsibility the BOEMRE has the following priority goals: promote the minerals resource development on public land, protection of the human, marine, and coastal environments, receipt of fair market value from the development of mineral resources and preservation of free enterprise competition. The BOEMRE's oversight and regulatory framework ensure production and drilling are done in an environmentally responsible manner, and done safely (BOEMRE, 2011).

In the GoM, the removed structures started being record in 1973 (Griffin, 1998) and it is estimated that between 100-150 platforms are decommissioned annually (Watson, 1998). Owners present all possible decommissioning and abandonment scenarios and the BOEMRE makes the final decision on the best alternative. Once, a final decision is made, the owner is the party responsible for the implementation of the selected plan.

During the late 1980's it became evident that an American Petroleum Institute (API) process was required for assessing the structural integrity of existing jacket platforms in the United States OCS. The approach would be different from the design of new platforms and as such required a new section of the API Recommended Practice (RP) 2A. The offshore community then established an API working group that developed the assessment approach and released it in the mid 1990's as "API RP 2A, Section 17 – Assessment of Existing Platforms." Since then, Section 17 has become the worldwide recognized approach for assessing existing platforms. It has been used many times around the world and particularly in the Gulf of Mexico. In August 2003, the MMS released a Notice to Lessees and Operators (NTLs) requiring GoM platform owners to assess their platforms to Section 17 requirements. (Wisch, 2004).

API RP 2A - Section 17 provides guidelines for performing a fitness-for-purpose assessment of steel jacket platforms based on their consequences of failure. It recommends a multi-stage assessment procedure for platforms in United States waters, and the use of more sophisticated structural analysis methods to determine the strength of platforms and their acceptability. The recommended procedure involves design level and ultimate strength analyses. The ultimate strength analysis reduces conservatism and attempts to provide mean estimates of platform system (global) capacities using the best estimates of individual component (local) stiffnesses and capacities (PMB Engineering, 1997).

From Friday October 15-2010, oil and gas operators in the Gulf of Mexico have 120 days to submit their plans to the Bureau of Ocean and Energy Management and Regulatory Enforcement (BOEMRE), detailing how they intend to set permanent plugs in nearly 3,500 non-producing wells, and dismantle roughly 650 idle oil and gas production platforms (Idle Iron NTL, 2010).

Following every major hurricane, the BOEMRE send to platform owners a NTL requesting to execute inspections to the infrastructures that were exposed to hurricane winds. For platforms on the path of the hurricane that were exposed to strong winds, operators are required to conduct a Level I surveys that are related to above water visual inspections. Consequently, platform owners report the progress or results of the inspections to the BOEMRE, and indicate if platforms had no damage, incurred minor or major damage, or were destroyed (Kaiser, 2010). Level II is related to general visual inspection to the whole structure; it is intended to detect excessive corrosion, accidental or environmental overloading, seafloor instability, design or construction deficiencies, excessive marine growth, etc. Level III and IV are more detailed inspections depending on the risk found by previous ones. Level III analyzes pre-selected high risk areas where damage is suspected and it requires cleaning of marine growth. Level IV uses more detailed technology to find damage or confirm suspicion of it.

Regarding the international regulations, once a country is a party to Conventions, the national laws are modified in order to include the intention of the international agreements. Globally, the regulatory policy has evolved in the last decades establishing equilibrium between the need to protect the environment, navigation, fishing, and other users of the sea on the one hand, and to take into account the safety, technical feasibility, and cost of decommissioning on the other (Griffin, 1999).

Geneva Convention on the Continental Shelf, 1958. It was the first international removal standard that according to the very shallow water production of that time considered in Article 5 the following:

''Any installations which are abandoned or disused must be entirely removed.'' (Convention on the Continental Shelf, 1994)

With time the inexpensive and easy removal process became more challenging in deeper waters and changes were needed to reflect the current and future situation.

Currently the main international conventions that influence decommissioning are:

The United Nations Convention on the Law of the Seas (UNCLOS), 1982. This convention in Article 60.3 allows partial removal of structures:

> ''Any installations or structures which are abandoned or disused shall be removed to ensure safety of navigation, taking into account any generally accepted international standards established in this regard by the competent international organization. Such removal shall also have due regard to fishing, the protection of the Marine environment and the rights and duties of other States. Appropriate publicity shall be given to the depth, position and dimensions of any installations or structures not entirely removed.'' (United Nations Convention on the Law of the Sea, 1982)

The International Maritime Organization (IMO). This organization is responsible to develop and maintain a comprehensive framework for removal of offshore installations worldwide. The 1989 IMO guidelines require the complete removal of all structures in water depths shallower than 100 m and jacket weight lighter than 4,000 tones. It allows partial removal of installations in deeper waters, leaving a minimum 55 m of clear water for navigations safety. All structures installed after January 1, 1998, must be designed to allow complete removal. Some exceptions apply in case the installation will serve other purposes if it is permitted to remain partially or wholly in place and when complete removal is not feasible technically. The IMO consent the possibility for a Rigs-to-Reefs programme or any other new secondary use of a structure (Griffin, 1999).

The London Convention (LC) or London Dumping Convention. This 1972 Convention (and the subsequent 1996 protocol) provided a generic guidance for any waste that can be dumped at sea and specified its different classes, including platforms and other man-made waste. The convention partially covers the conversion of platforms to reefs. The new guidelines were adopted in 2000 (Towmey, 2010).

2.2 Types of Platforms

There are many different types of offshore facilities including fixed concrete base platforms, steel-legged platforms and Floating Production, Storage and Offloading system. The majority of installations that have been decommissioned to date are steel-legged platforms which weight between 100-2,000 tons (BOEMRE, 2011). The illustration 2 shows the different types of deepwater systems in the Gulf of Mexico.

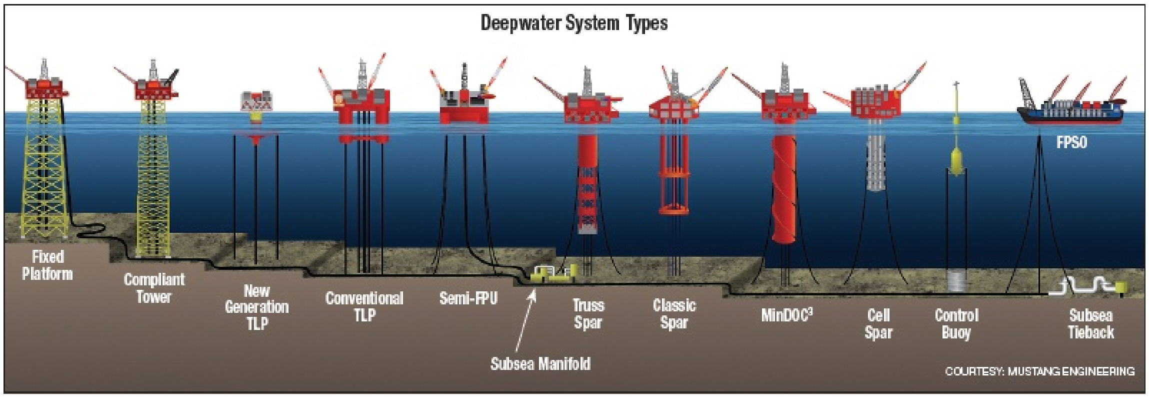

Illustration 3: Different Deepwater System Types (Mustang, 2011).

The following is a brief description of the different types of deepwater systems available in the GoM:

Fixed Platform (FP) consists of a jacket and a deck which make up the foundation for the surface facilities. The jacket is a tall vertical section supported by piles that are anchored into the seabed. The deck is located on the top of the structure and it is the place where the living quarters, a drilling rig, and production facilities are placed. The fixed platform is common in shallow water depths.

Compliant Tower (CT) is a slim tower and a piled foundation that can hold a conventional deck for drilling and production operations. The difference between this tower and the fixed is that the CT resists larger lateral forces, and is usually used in and lower deep water depths.

Tension Leg Platform (TLP) is a floating structure held in place by a mooring system. The set of tension legs or tendons (mooring system) are attached to the platform and connected to a foundation on the seafloor. The larger TLP's have been successfully used in deepwater depths.

Mini-Tension Leg Platform (Mini-TLP) is a cost-efficient floating mini-tension leg platform designed for production of smaller deepwater reserves that under other conventional production systems will be uneconomic to produce. It can also be used in the early production stage of a field. The world's first Mini-TLP was installed in the Gulf of Mexico in 1998 (BOEMRE, 2011).

Seagoing Platform for Acoustic Research (SPAR) consists of a large diameter single vertical and hollow cylinder structure supporting a deck. The drilling and production equipment is located in the platform topside. This type of platform has three types of risers (production, drilling, and export), and a hull with a lateral catenary system of 6 to 20 lines keeps the spar on location. The SPAR's are presently used in deepwater depths with the possibility of being used in ultra deep waters.

Floating Production System (FPS) consists of a semi-submersible unit that can host drilling and production equipment. It is anchored in place with large, heavy anchors, or through dynamic positioning. The production from subsea wells is transported to the surface deck by flexible or rigid production. The FPS can be used in a wide range of water depths from shallow to ultra deep water locations.

Subsea System (SS) could be use for single subsea wells producing to a nearby platform to numerous wells producing through a manifold and pipeline system to a distant facility. These systems are presently used in ultra deep water depths.

Floating Production, Storage & Offloading System (FPSO) is a floating tank system able to receive, process and store production from nearby platforms. The oil and gas production could be offloaded to a tanker or transported through a pipeline. FPSOs are an alternative for marginally economic fields located in remote deepwater areas where a pipeline infrastructure does not exist yet. Currently, there is one FPSO approved for use in the Gulf of Mexico.

2.2.1 Facility Decommissioning Options

There are several decommissioning options allowed under International Laws, it is up to the owner and the government to choose the option that best benefits all the parties and stakeholders involved in the project. Illustration 3 refers to the different decommissioning scenarios. Some practices are preferred depending on the location of the structure, company policy or government regulations.

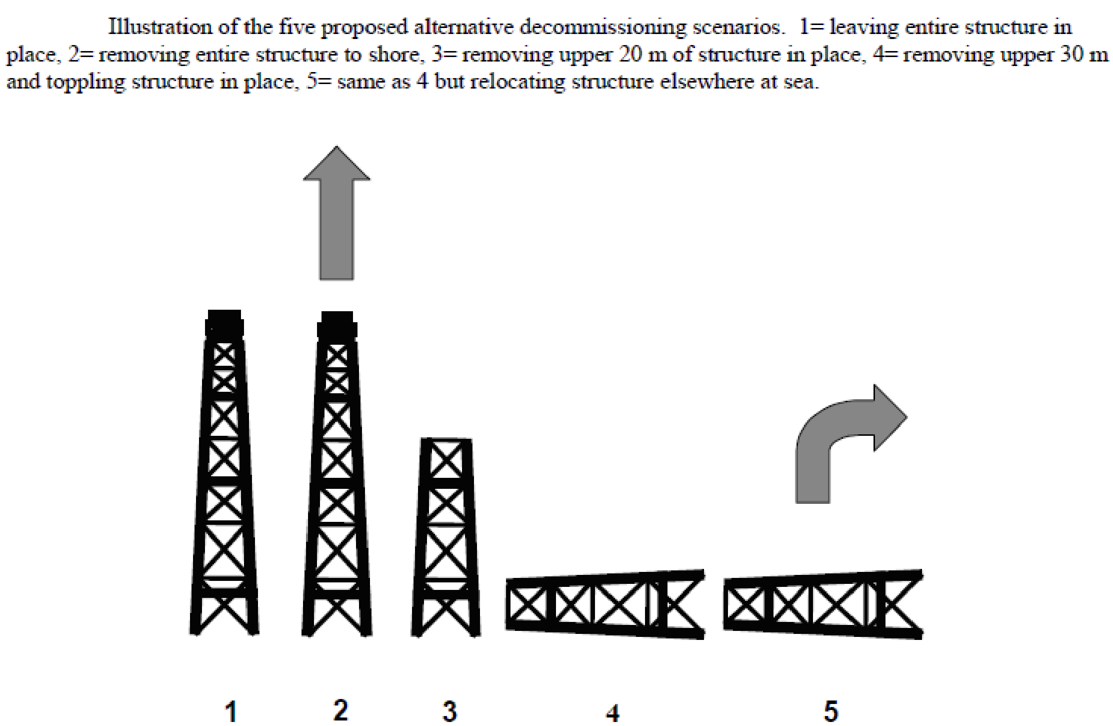

Illustration 4: Platform Decommissioning Alternatives (Carr, 2003)

A platform jacket could be left in place but this option is frequently not possible due to the international and national laws that require removing structures no longer having ongoing operations. In addition, the owner will have to assume maintenance costs, accident liability, collisions, and other possible navigational hazards that complicate this option. This alternative is best suitable when substitute uses are associated to the platform such as becoming a logistic emergency point, living quarters, a heliport, etc.

When the complete removal option is chosen then the structure has to be completely removed and transported to onshore for recycling or disposal. Recycling equipments is possible but recycling a platform has a lot of limitations that combined with the economical effects may not be the best alternative at sometimes. Platforms are designed for a specific operational condition, volumes, location and many alterations may be needed that will increase the final cost if the recycling use is pursued.

The top portion of a platform could be removed to 20-30 meters subsurface and the remaining lower portion left standing in place (“topping”). This partial removal should allow safe navigation and it is permissible under IMO for large structures. The jacket is cut to the required depth and the bottom portion stays on the seabed. The top part may place next to the bottom portion of the jacket on the seafloor, recycle or disposed onshore.

When the structure is toppled over in the same location is called “toppling”. The upper portion of the jacket is toppled in-situ leaving an unobstructed water column. The operations involved in this option require high degree of precision and control to ensure the structure is safely toppled as planned.

As mentioned previously, when structures are moved to a new location, the opportunities for reuse of jackets in other field sites are limited as they are designed for specific production requirements, water depth, environmental criteria, soil conditions, etc. Also, degradation in the integrity of the structure such as fatigue and corrosion could impact the performance. However, some owners still consider reusing jackets for specific cases due to the potential cost and time reduction benefits.

2.2.1.1 Removal and Reuse

There are a number of options for the reuse of offshore production facilities, rather than scraping them. Some of the Mobil Offshore Production System (MOPU) has been reused on 4 or 5 different fields over a 25 year life of the system. The capital cost per location steadily drops as facilities are reused, and the construction and installation time goes from a year or two to several months (Proserv, 2009).

For a long time, conventional jacket type platforms have been reused in the GoM, this is a practice that is not longer popular because of the production declination in shallow waters. Instead of this jacket platform being reused in the GoM there is a market in international waters that have enough reserves to justify the cost reconditioning them and transporting them to the new location (For example, West Africa).

Some structures such like TLPs are quite simple to reuse in the GoM or an international location, this option is economically much better than scraping them. Some modifications in the tendons and anchoring system may be needed according to the new conditions.

Semisubmersibles units could be reused in the GoM or in areas with milder storm activity. Again, modifications may be need in the mooring system in order to comply with the new conditions.

SPARS are structures more difficult to reuse due to their limitations moving around. They are very expensive so owners usually try to get the most out of them producing several fields with tie backs.

Regarding the FPSOs are the easiest structures to relocate from one field to another depending on similar characteristics such as (pressure, temperature, gas/oil ratio, specific gravity, water cut, sour gas content, sand content, etc). If modifications to the facility equipments are required then time should be allowed to re-engineering and refit of the FPSO. Old tankers are typically converted to FPSOs and as FPSOs they could last for many years more (additional 20-25 years).

Other equipments like subsea well heads, trees and production manifolds are routinely decommissioned and removed. They could be modified and reused for future projects. Reuse is an option mainly when they have high technical specifications that allow them to have a longer production life.

Regarding the subsea pipelines the alternatives for reuse are not common. Usually the procedure to handle a pipeline that will be decommissioned is to flush them with water, proceed to disconnect and abandon them on site. The options for all other electro hydraulic umbilical control cables are more frequently retrieved reeled up, reconditioned, tested, recertified and reused.

Practical cost effective solutions developed by individual operators or contractors eventually evolve into accepted industry practices and trends. In addition to trends, new lift techniques and technology have been or will be introduced to the GoM which will potentially offer major costs savings.

It is concluded that re-usable production systems provide considerable potential for cost effective field development In relatively shallow waters, the use of a concrete platform combined with jack-up drilling provides a particularly cost efficient production system, in particular if commercial available production systems are leased or if the services of a competent subcontractor is being utilized. A thorough analysis of taxation regimes is required. A careful involvement by company in supervising that the work be performed according to company standard is furthermore required. (Gudmestad, 1993)

2.3 Topsides and Decks Removal Options

2.3.1 Heavy Lifts (Illustration 5 and 6)

The market challenges for the offshore heavy lifts industry have frequently been formidable, given the historically wide fluctuations in the price of oil, the booms and busts in the offshore industry, and the long lead times and huge capital commitments required for new vessel construction (JPT, 2011).

Operators executing removal try to reduce the amount of work required offshore, contracting vessels that perform as many lifts as possible without breaking down anything offshore. The dismantle of the structure is done onshore. This is an efficient and safer way that reduces risk.

Illustration 5: Heavy Lift Example (Versabar, 2011)

Illustration 6: Heavy Lift Example (Versabar, 2011)

2.3.2 Small Piece Method (Illustration 7)

It is a method used mainly in the North Sea for removal of offshore installations and where simplicity is the key to cost efficient execution. This methods has the following main advantages: Utilization of logistics chain to and from offshore installation, decommissioning activities can be performed in parallel with P&A activities, optimize front running team to logistic chain to and from shore, large pieces of the platform can be lifted to the service vessel for further processing, reduce conflicts between decommissioning and P&A activities by thorough combined planning, high flexibility together with other removal methods, use of local labor and equipment and no need for crane barges and marine vessels (AF Environment, 2011) .

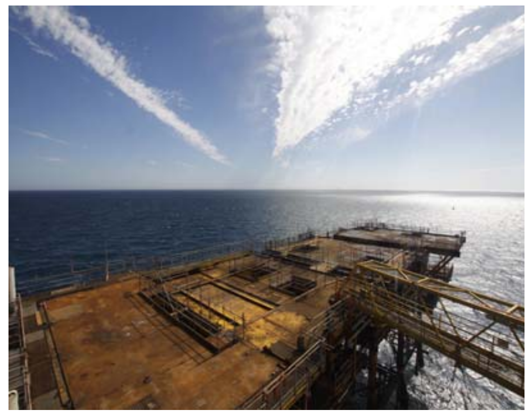

Illustration 7: Example Small Piece Method (AF Environment, 2011).

2.3.3 Reverse Installation

Reverse installation is a misleading term as the removal of an installation is rarely the same as its installation. The majority of topsides were installed by crane vessels. Hence reverse installation of topsides will involve the use of crane vessels. The size of the lifts and the lifting capacity of the crane vessel will determine the number of lifts required to remove the modules and any module support frame. They would then be placed on either the deck of the crane vessel or cargo barges to be taken to their final destination. There are some fundamental governing factors that would need consideration in the design of lifts, for example the structural integrity of the topside components, the design of any module reinforcement, padeyes and lifting frames (Bayou, 1997).

One of the advantages of this removal technique is that the technology and procedures are proven but costs could be high and the operations involved for reuse may not be as cost effective as other techniques involving less time and more integrated lifts. An exception to this would be self-contained modules such as living quarters and drilling equipment.

2.4 Pipeline Decommissioning

The main options for decommissioning offshore pipelines are either leaving the pipeline in-situ of removing it to shore and disposing it on land. If the first option is considered then it may be left in place or buried. If the removal is pursued then some of the methods to remove it are the reverse lay barge recovery, J-lift recovery, sectional recovery and tow recovery.

In the GoM is common to find most of the pipelines buried and abandoned in place after cleaning and disconnection, very few have been removed (Nord Stream AG, 2009). For deepwater pipelines decommissioning the size and the depth are two factors to be considered in order to calculate the volume to be cleaned. Technology has been implemented to flush pipelines in water depths over 8,000 feet (Proserv Offshore, 2009). After flushing and purging the pipeline the flushing fluids have to be properly disposed (water treated to be discharged as per government requirements and oil/gas to be sold). If the pipeline is going to be left in place, a diver or remotely operated vehicles (ROVs) in deeper waters could cut the ends and plugged the pipeline.

It is been suggested that pipelines could be removed by a reverse lay process using semi-submersible lay barges or by sea bed cutting and lift removal in appropriate segment lengths. The reverse lay barge recovery is likely to be more cost effective (Gorman, 1998).

There are no regulations that mandate the removal of subsea pipeline as far as they do not obstruct navigation activities. In addition, to the high cost involved with the removal and all the risk of all personnel that could participate in a removal job, the better alternative is to leave the pipeline in place and reuse it if possible.

2.5 Rigs-to-Reef Program (RTR)

The underwater portion of the oil and gas platforms is typically a metal lattice structure, which is anchored into the ocean floor. Within a short period of time of the installation the underwater structures has a vast marine environment, invertebrates and plants attached to it. Within a year the structure may be completely covered with all the kind of organisms that attract fish species and other kind of invertebrates creating a complex food chain (BOEMRE, 2011). Such structures could be toppled in site and create artificial reefs that positively impact commercial and recreational fishing and diminish the consequences of destroying the complete ecosystem once the structure is completely removed. This idea started as an innovative way to use obsolete platforms and create policies to artificial reef building. As seen in illustration 8, the marine life around platform is vast.

Illustration 8: Artificial Reefs, Oases for Marine Life in the Gulf (Artificial Reefs, 2010)

Decommissioned oil platforms have been estimated to last as long as 300 years and, when properly sited proved to be able to withstand hurricane force conditions. A number of Gulf demonstration rigs-to reefs projects proved that platforms possessed the needed characteristics of stability, durability, availability, and function and were quickly recognized as the best material of opportunity for artificial reefs (Kasprzak 1998).

In August 1983, Secretary of Interior, James Watt, created the Recreation, Environmental Enhancement and Fishing in the Sea (REEFS) task force with the following objective:

> “Pave the way for aggressive movement towards a national rigs-to-reefs program which will enhance fishery resources and improve recreational and sport opportunities with in America’s offshore marine environments (DuBose, 1985).”

The primary agenda of the REEF task force was to assess the use of obsolete platforms as artificial reefs as a means to enhance local fisheries and to develop policy that set national standards for artificial reef building (Carr, 2003).

The entities that regulate the REEFS program are the States, the U.S. Army Corps of engineers, and the BOEMRE which once the production has ceased regulates the use of oil and gas structures as artificial reefs. The reef plan must comply with the criteria in the National Artificial Reef Plan and the permitting requirements of the U.S. Army Corps of Engineers. Artificial Reefing is encouraged by the BOEMRE.

A great amount of species could be found around oil and gas platforms, such as: Loggerhead, hawksbill, green sea turtles, corals, octocorals, black coral, sponges, bryozoans; and fish such as grouper, snapper, jacks, etc. (Boland, 2006). It is been reported that 10,000- 30,000 adult fish reside around a single platform in an area about half the size of a football field (Stanley, 2000).

The first use of an oil and gas structure for a reef occurred in 1979 with the relocation of an Exxon experimental subsea production system from offshore Louisiana to a permitted artificial reef site offshore Apalachicola, Florida (Dauterive, 2000). The State of Louisiana is pioneer among the Gulf States in establishing the most comprehensive artificial reef policy where the ownership and liabilities of the platforms is transfer to the State once is decided that the platform is going to be decommissioned. The Plan established an Artificial Reef Trust Fund for funding costs associated with each artificial reef project (Kasprzak, 2000). When a platform donation is made to the REEFS program the owners of the structure are asked to donate to the Artificial Reef Trust Fund half of the cost savings related to avoided disposal costs. Historically, approximately 8% of the platforms decommissioned in the Gulf OCS have become used in the Rigs-to-Reefs program (Dauterive, 2000). Most reefs have been established off the coasts of Louisiana and Texas, and few in Alabama.

In the GoM, liability is transferred to the state at the point the structure is accepted by the state as an artificial reef, under the state's respective artificial reef programs. The oil structure is transferred to the state (or, in some cases, another public entity) after the state has obtained a Corps of Engineers permit for an artificial reef development. (McGinnins, 2001)

2.6 Wells

Once the wells are permanently abandoned, then the platform decommissioning might start. During the productive life of a field, some wells may become inactive because of decrease on the production and the economic returns. The inactivity could be temporary, or permanent. The illustration 4 is a typical wellbore design of an abandoned well in the GoM. The average cost for removing a structure sits at US$1.2M and to plug a well it sits at $775,000 (Decommissioning activity in the Gulf of Mexico, 2009).

Since 1947 approximately 34,000 wells have been drilled in the GoM OCS Region, and about half have been permanently abandoned (PA) according to the publicly available MMS (now the BOEMRE) "borehole" database (Nichol, 2000). Of the remaining wellbore, a significant number are non-producing.

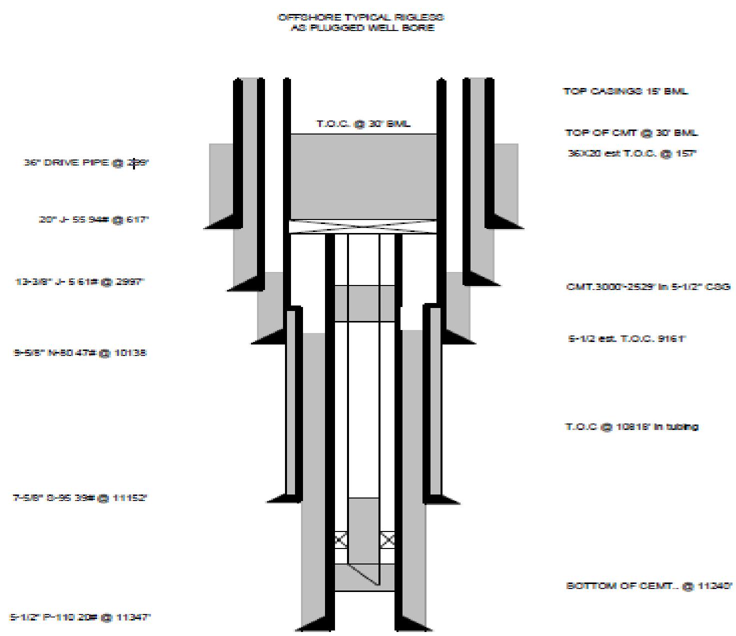

Illustration 9: Typical GoM Plugged and Abandoned (P&A) Wellbore (Thornton, 2000)

2.6.1 Abandonment Options

The objective for any well abandonment is to isolate permanently all subsurface formation in the well. This means properly abandoning all producing zones and protecting aquifers while minimizing cost and risk. (Tettero, 2004). Planning is the key factor in the well abandonment process, which involves a number of factors like for example the geology conditions, the water depth, and the well design.

As per BOEMRE regulations for placing a well in temporary abandoned (TA) or shut-in (SI) status, in addition to meeting the mechanical requirements (for plugging and stub clearance) an operator must:

> "……provide, within one year of the original temporary abandonment and at successive one-year intervals thereafter, an annual report describing plans for reentry to complete or permanently abandon the well." (30 CFR Ch. II, 250.703)

In the case for shut-in wells, the current regulations are:

> "…completions shut-in for a period of six months shall be equipped with either (1) pump-through-type tubing plug; (2) a surface controlled Sub-surface Safety Valve (SSSV), provided the surface control has been rendered inoperative; or (3) an injection valve capable of preventing backflow." (20 CFR Ch. II, 250.801 (f))

Over time, all the inactive wells represent a high risk to safety and environment; this issue should be considered against the potential benefits of retaining them for future recovery of hydrocarbons.

As a way to minimize abandonment cost, especially in shallow waters, rigless practices are proven to be safe and cost effective to plug and abandon wells in the GoM. Using Coiled Tubing units eliminate the need for a rig and operations could be completed in shorter time than using traditional methods with rig interventions. This procedure requires pumping the first plug and the intermediate plug through the tree. Both plugs are tagged and tested before the tree is removed. The final plug is set after the well is secured and the tree removed. (Thornton, 2000)

Chapter 3: Relevant Issues that influence Economical Analysis Decisions

The GoM is an active market for United States contractors involved in decommissioning activities. According to the number of platforms and subsea equipment the GoM is the largest hydrocarbon producing area in the world. The active hurricane season and the consequences of destructions that bring to the economy in the world make it even more relevant. Decommissioning is an unpredictable, challenge, potentially hazardous and costly activity, due to this unpredictability high fluctuation is observed in the cost and volume of the jobs. The government and major players in the GoM have developed a more proactive approach and tighter regulations that are consistent with the importance of the issue. Other factor that makes the topic relevant is the fact that more deep waters platforms are being installed. Portfolios and risk analysis should reflect the importance decommissioning is gaining in the economics of a project.

The economics of decommissioning are usually considered in terms of “least cost liability” as opposed to “return on investment.” Decision criteria associated with abandonment options thus generally favor minimum cost alternatives as the preferred means of most disposals. The factors that determine when a structure will be removed, as well as how it will be removed, are driven by engineering, economic and safety criteria that is time, location, and operator specific (Kaiser, 2005).

Some major oil companies sell off depleted offshore fields to smaller ones that could maximize economical return lowering operating cost and squeezing the last drops out of the fields. There are a lot of justifications behind the decision of selling a field; one of them could be to get rid of the decommissioning liabilities. In some cases the decommissioning and abandonment costs take smaller companies to go bankrupt in depleted uneconomic fields.

Actually, many of the aging offshore oil and gas fields in the world, mainly in the GoM and the North Sea, are close to the end of their productive lives. Consequently, in the next 25 years, it should be expected that over 6,500 installations would be decommissioned. The estimated cost to decommission such installations ranges from US$ 20 billion to US$ 40 billion (Coleman, 1997).

3.1 Key Drivers for Offshore Decommissioning and Abandonment Cost Estimate

There are several factors that are relevant when calculating the decommissioning and abandonment costs. The main ones are listed below and every company evaluates the relevancy of each when choosing an alternative.

The operator must research drilling, construction, production and operation files to obtain as much historical information as possible. The research will determine the installed condition of the wells, structure and equipment and identify any items that may affect decommissioning operations. A field inspection should be conducted of the platform to examine the wells, structure and equipment in order to prepare detailed decommissioning procedures. As-built drawings should be verified during the field inspection. The biggest challenge is that in many cases, the information desired is not available and in some cases, portions of the information required are not even available. The quality of the information used in planning directly affects the costs of the decommissioning project. (Thornton, 2000). "One of the key aspects is the lack of knowledge of the state of the facility and the integrity of the components you have to remove", said Bruce Gresham, vice president for North America at Heerema Marine Contractors US. "When facilities are no longer producing, maintaining them becomes less of a priority for an operator, certainly. And then it's about record keeping, being able to document things that have altered or significantly affected the facility. There is just going to be –and this is our experience- a tremendous amount of uncertainties. Some of the biggest challenges are the unknowns, the surprises, and how to establish a fair balance of contractual risk between the contractor and the operator." (JPT, 2011).

The contracting strategy should be analyzed carefully in order to optimize resources and perform the job in a safe manner. Once the scope of work is defined, it should up to the owner to determine if it is the best interest to bid the job as a whole or splitting it in several contracts. Experienced companies should be invited to participate in the bid process, since decommissioning is an operational type of activity. If the contract is split could be an optimization in time and price. All cases are different so both approaches should be considered. If the scope of work is split, then every phase has to be breakdown in segments that address jobs. For the preparation phase an option could be to award three different contracts as follows: Decommissioning of facilities, plug and abandonment of the wells and hook-down of cables and piping. Second there is a removal and dispose that include other engineering details and actual removal and dispose of the equipments and flowlines. The terms and conditions should be revised by a legal team and the remuneration structure should contain detailed information about possible bonus, lumps sums, combination of this, or others. The compensation item should reflect uncertainty such as weather, lack of information, etc. The lump sum contracts do not provide incentives for HSE performance and the final deliverable, being the environmental inventory account may suffer under a lump sum regime (Gram, 2011). If using single lifts or small piece methods, either way, proper accounting methods have to be implemented to trace materials between offshore and onshore.

Waste Management is one the key drivers when estimating costs and it is an issue approached as per every company's policy that should be analyzed in detail either if the waste is going to be disposed at sea or onshore, reuse or recycled. Once the safety inspections identify the hazardous materials, resources have to be delivered for their proper collection and transportation. Asbestos, batteries, material contaminated by mercury, hydrocarbons, heavy metals, etc. should be handled carefully to protect workers and the environment.

The operating procedures are other key driver that should be done including all the legal concerns involved during the decommissioning and abandonment, the health, safety and environment (HSE), contract strategy, etc. Regarding the legal issues, they are analyzed on a case-by-case as the decommissioning and abandonment process. Companies have to comply with an extensive legal framework in order to remove and dispose offshore installations. The legal framework intents to protect the environment, navigation, fishing and other sea users, tanking into account safety, technical feasibility and the cost of decommissioning.

Numerous HSE issues arise with the decommissioning of offshore platforms. The use of explosives, diver exposure and multiple heavy lifts are some of the potential risky jobs that could affect greatly the decommissioning and abandonment and increase the cost. Offshore dismantling of steel structures involves significant hazards due to uncertainty about the structural integrity and precise weights and centers of gravity of components, especially when during the life of the installation several modifications to the structure have been performed. Furthermore, risks to safety have been estimated to be approximately 50% higher for total removal of a structure compared to partial removal, due to the higher exposure of personnel to hazards during a total removal (Anthony, 2000). During the HSE assessment a critical decommissioning impact is related to the disposal process that impacts the sea, land and air, so a careful detailed environmental assessment is required to deal with the issues, the concerns and the alleviation of the impacts.

An appropriate balance has to be achieved between the safety, environmental and financial risks. The likely environmental impact is largely independent of the choice between decommissioning options. If this finding is true then the choice of which decommissioning route to take hinges firmly on the safety and cost factors (Gorman, 1998).

Regarding pipelines decommissioning is important to note that their removal is a high cost operation that varies from the pipeline location and the impacts on the environment, especially from the marine environment are minor. Compared with the abandon in place option, pipeline removal requires 70% more energy (Nord Stream AG, 2009)

During the operational life of an asset, the decommissioning and abandonment costs are reviewed on an annual basis. New technologies and costs need to update the cost estimation, a review of the reserves vs. the operational cost need to determine when the best time to cease production is and the identification for additional opportunities that could improve the economics of the field. Planning ahead and an effective project management of the decommissioning job could significantly reduce the decommissioning liabilities and optimize the recovery of an important portion of the overall expense of removing an offshore structure. Platform size and water depth are two considerations that dictate how much a decommissioning project will cost.

The cost to decommission the world's offshore platforms has been estimated at US$20-40 billion. The North Sea area accounts for approximately 60% of the worldwide decommissioning costs, although it only includes about 9% of the platforms. This is attributed to the size of the North Sea installations and the severe environmental conditions of the area, making decommissioning efforts particularly difficult (Anthony, 2000).

Decommissioning costs are driven by the complicated logistics process for the structure and equipments removal that are needed to ensure structural integrity, assurance of spill free operations from harmful and hazardous materials, and the cost optimization of all the services contracted. When decommissioning scenarios such as leaving fully or partially structures in place are decided, the owners should plan for long-term monitoring costs that go according to the location, complexity of the structure and the government regulations.

The deeper the oil and gas fields are located the higher the costs, also the most likely is that the complexity of the operations is higher which contributes to increase the cost as well. As mentioned in several occasions through this study, the decommissioning and abandonment process is a case-by-case so different decommissioning options will generate different cost estimates based on the unique characteristics of the platforms and wells. Options such as partial removal and toppling in situ have been estimated to offer potential savings of 15-70% compared to total removal due to the reduced offshore deconstruction time and thus, offshore spread utilization (The Oil Industry International Exploration and Production Forum, 1995).

The marginal cost-effectiveness specifically for the scenario complete removal vs. donation to an artificial reef program, is relatively little for shallow water platforms. These marginal differences increase for deep-water platforms and because of this reason and their larger donations to the artificial reef funds, decommissioning in deepwater platforms as artificial reefs is more attractive to the parties, platform owners and program managers.

The main cost elements related to a decommissioning project are the mobilization, demobilization, project management, surveys pre and post removal, contractors, final disposal, overhead and contingency plans.

Based on business statistics revealed from GoM and projects such as Odin Platform in the North Sea, the money spent on total removal of offshore structures is distributes as follow:

1. Lifting vessels and cargo boats (60%)
2. Site Clearance (18%)
3. Decommissioning (11%)
4. Mobilization and miscellaneous (7%)
5. Pipeline Abandonment (4%) (Alghamdi, 2005)

The Engineering and Planning phase of decommissioning cover several phases from scope of work up to contract strategy that best suits the field. The cost will depend on the kind of technology used, the complexity of the decommissioning and the dismantling procedure to accomplish the decommissioning job. This phase includes the proper planning for tasks such as permitting and regulatory compliance, the platform preparation, the plugging and abandonment of the wells, the conductor severing and removal, the mobilization and demobilization, the pipeline decommissioning and the material disposal.

The different decommissioning options have to inevitably analyze the best options that satisfy the different groups involved in a job of this magnitude. The principal spheres of special interest are the environmental, health and safety, financial and political. The literature and the established conventional wisdom has identified the Best Environmental Option as the paradigm for accepting an abandonment strategy, but it is necessary to examine what is Best Practicable from each spheres of interest. The different options could be:

- Best Practicable Environmental Option
- Best Practicable Safety Option
- Best Practicable Financial Option
- Best Practicable Political Option (Gorman, 1998)

The conjunction of all of these options could be defined as the Best Practicable Engineered Option. And the term “best” is relative to the company’s policies and their stakeholders.

Alternatives such as “Mothballing” could be attractive in a certain moment of the field, in order to decrease costs and find a potential user of the facility. This is an alternative in small fields and when costs are higher than revenues. With volatile oil and gas prices this choice could be analyzed in more detail.

Due to the high cost the decommissioning cost brings to the economics of a field, and adding the environmental and political concerns when a job of this kind is performed, then the reuse of the facilities is a "green" alternative that affect the Net Present Value (NPV) of the field to be decommissioned and the NPV of the new field. There are cash flow and tax consequences when reuse happens.

The political importance for the petroleum and gas industry involves public and private interests which affects the decision-making process. The Brent Spar events, which was a high profile publicity case generated by Greenpeace in 1995 against the disposal plan of the Shell operated North Sea oil storage and tanker loading buoy in the Brent oilfield. This Greenpeace campaign on the Brent Spar case has demonstrate that it is not up just to the regulators but also it is an issue that all stakeholders' opinion should be taken into account when performing a decommissioning job. Public opinion is volatile and difficult to measure and it often neglected because lack of a proper methodology to address the issues and find the way to quantify results. Risk assessment techniques can help to evaluate the financial consequences that negative publicity could bring to a project.

Oil companies –like the counterparts in other sectors- are struggling to meet the ever rising expectations of corporate responsibility. As recently as a decade or so ago, a "responsible" company was the one that made a profit without breaking any laws or causing any high-profile disaster or scandals. The term now implies much greater accountability for –as well as a higher degree of transparency on- the environmental and social dimensions of a company's operations (Aloisi, 1999).

The oil industry has made an important progress identifying all kind of issues related to external stakeholders. The basic principle underlying the “right-to-know” (RTK) movement is that people deserve access to information about companies’ actions that directly affect their welfare. Traditionally, the focus has been on environmental health issues –but the RTK concept is expanding to encompass a company’s social and economic effects as well, such as employment or land-use decisions. (Aloisi, 1999).

3.2 Accounting for Future Decommissioning

All the future cost related with the production facilities decommissioning and wells plug and abandonment have to been reflected in the accounting books. Also, all costs of bringing back and returning the place to the initial environmental conditions have to be taken into account. An asset is considered retired when it is permanently out of service, either through sale or disposal. Retirement obligations can be recognized when the asset is placed in service or during its operating life at the point when its removal obligation is incurred.

In June 2001, the Financial Accounting Standards Board (FASB) issued Statement of Financial Accounting Standards (SFAS) No. 143, “Accounting for Asset Retirement Obligations” (ARO’s) for those companies listed on the New York Stock Exchange. The SFAS No. 143 defines the criterion for decommissioning and abandonment costs of production assets allocation and establishment, it provides information about the way companies are required to report the cost allocation in the company accounts which are auditable material. In general, companies are required to recognize much sooner any legal liability associated with the future retirement of tangible long-lived assets.

Once a liability for retirement obligations is identified, the company should capitalize the exact amount as part of the cost basis of the related long-lived asset and allocate it to the Depletion, Depreciation and Amortization (DD&A) over the life of the asset. Any changes in the obligation need to be recognized by modifications (up or down) to the carrying value of the asset retirement obligation (ARO) and the related long-lived asset.

Chapter 4: Conclusions and Recommendations

4.1 Summary

Decommissioning is an important topic in the oil and gas industry and it is even more relevant when a field has been producing for quite some time. Also, the active weather in the Gulf of Mexico has a huge impact in the subject and requires a constant revision of the decommissioning and abandonment plans.

Several alternatives for decommissioning and well abandonment have been researched along this project; it is the operator/owner responsibility to present all recommendations to the government. Each case should be evaluated on a case-by-case basis and the government authorities are the ones who will make the final decision on the most suitable proposal.

The cost of removal, as a function of depth, is the main factor in the decommissioning and abandonment assessment phase. The Rigs-to-Reefs program has provided a selection of decommissioning scenarios not available before. This program is an alternative that could provide cost savings for certain cases in shallow and deepwater projects. Legislation relieves platform owners of liabilities after the platform is donated and they are satisfied with the idea that ecological benefits (artificial reefs) are obtained as a consequence. The selection of this option strategy is taken by the owner who, for the most part, selects the most efficient cost-benefit approach.

Decommissioning is a final and difficult stage for any field, because it means the end of the productive life and the economic limit has been reached. But it is an important topic when analyzing the economics of an oil and gas field. There are several opportunities available that when combined with the economic analysis they will provide benefits to the owners/operator, government or others (third parties). Possibilities of selling a field when reaching economic limit could be explored and advantageous to third parties that specialize in this kind of projects.

4.2 Recommendations

Collective collaboration between different platform owners could allow the removal of several structures at the same time and maximize savings. The Government could contribute to this initiative by promoting change in legislation to allow this collaboration.

When dealing with small, marginal fields reusing equipments could provide a competitive advantage and improve the economical view of a project. Regulations could be implemented to incentive this option and all consequences should be analyzed to avoid future issues in the commissioning of the equipments at the new site.

More emphasis should be put in place at the initial stage of a project when designing facility equipments and platforms, in this way when the time to remove them comes the decommissioning will be easier to handle. This could bring more cost-effective and safer solutions during the decommissioning job.

Document control is very important during the any project management and becomes a key issue during decommissioning since lack of information could prolong the project and increase cost. The equipment inventory should be categorized and analyzed to take the best approach for the decommissioning. Information becomes critical when a field is near the end of the production life and when it is sold to other operators. Sometimes the owner of a platform is not the one that was involved during the construction phase, so basic information might be in their possession but detailed one is forgotten to hand over causing uncertainties during the decommissioning phase. Regulations and contractual provisions should address the transfer of data to new operators to assist important operations such as decommissioning. As the fields in the GoM mature the documentation control is a critical issue to address.

One challenge that the oil and gas industry have to overcome is the limitation in experience base because although an increase in recent decommissioning activity has allowed the industry some experience, there is still much to learn and accomplish on a larger scale, like for example in deep waters. The industry should keep emphasizing in the importance of training personnel and consider decommissioning an area as relevant as drilling, production, reservoir, etc. because experienced personnel should facilitate such complex abandonment and decommissioning operations.

Challenges ahead for the decommissioning industry include change in the regulations, insurance issues, risk identification and mitigation plans, legal and contractual structures to perform the job in the safer and environmental best manner, reuse of equipments and deep waters decommissioning which is a whole new area to explore that will bring new technology and lessons to learn from.

4.3 Conclusions

Decommissioning is a case-by-case study that involves a broad list of requirements and issues to analyze. Unlike a new investment, decommissioning of an existing platform cannot be avoided, but a company can select when the best moment to perform the job is. When key parameters are unknown the best alternative is to continue production, if possible, until the circumstances might be more favorable. It is thus part of the ongoing value of the project. It is also the opportunity cost of decommissioning today and can be used to determine the best time to decommission in the future.

Decommissioning in deep-waters as artificial reefs is more attractive to both platform owners and program managers due to the relatively higher cost-savings to platform owners and their greater contributions to artificial reef funds. However, other factors could contribute to determine what decommissioning strategy is selected as the best alternative for certain cases.

Glossary

API American Petroleum Institute

ARO's Accounting for Asset Retirement Obligations

BOEMRE U.S. Bureau of Ocean Energy Management Regulation and Enforcement

CT Compliant Tower

DD&A Depletion, Depreciation and Amortization

FASB Financial Accounting Standards Board

FP Fixed Platform

FPS Floating Production System

FPSO Floating Production, Storage and Offloading system

GoM Gulf of Mexico

HSE Health, Safety and Environment

IMO International Maritime Organization

LC London Convention

MMS Minerals Management Service

Mini-TLP Mini-Tension Leg Platform

MOPU Mobil Offshore Production System

NPV Net Present Value

NTLs Notice to Lessees and Operators

OCS Outer Continental Shelf

PA Permanently Abandoned

P&A Plugged and Abandoned

REEFS Recreation, Environmental Enhancement and Fishing in the Sea

ROVs Remotely Operated Vehicles

RP Recommended Practice

RTK Right-to-Know

RTR Rigs-to-Reef Program

SFAS Statement of Financial Accounting Standards

SI Shut-in status

SPAR Seagoing Platform for Acoustic Research

SS Subsea System

SSSV Sub-surface Safety Valve

TA Temporary Abandoned

TLP Tension Leg Platform

UNCLOS United Nations Convention on the Law of the Seas

USDOI U.S. Department of Interior

Bibliography

AF Environment Presentation. Decommissioning Summit. March 2011.

Alghamdi A. and Radwan A. Decommissioning of Offshore Structures: Challenges and Solutions. 2005

Aloisi J., Bennet N., Elkington J., Elvins L., Fennell S., Stibbard H. and Terry V. The Oil Sector Report: A Review of Environmental Disclosure in the Oil Industry. SustaAbility, United Nations Environment Programee, Engaging Stakeholders. 1999

Anthony, N.R., Ronalds, B.F. and Fakas, E. 2000. Platform Decommissioning Trends. University of Western Australia. SPE 64446. Oct 2000.

Artificial Reef Subcommittee, Guidelines for Marine Artificial Reef Materials, Gulf States Marine Fisheries Commission, Technical Coordinating Committee, FWS Grant Agreement No. GS-96, January 1997.

Artificial Reefs: Oases for Marine Life in the Gulf of Mexico. September 2010. Retrieved from http://www.gomr.boemre.gov/homepg/regulate/environ/rigs-to-reefs/artificial-reefs.html

Bayou A. Topside Removal Techniques –Technical Note AMOCO. August 1997

Boland, G., Sinclair, J., Childs, S. Gulf of Mexico Offshore Oases. Teacher Companion. March 2006

BOEMRE (Bureau of Ocean Energy Management, Regulation and Enforcement). Retrieved from http://www.boemre.gov/aboutBOEMRE, http://www.gomr.boemre.gov/homepg/offshore/deepwatr/options.html

Byrd, R. A Gulf of Mexico Offshore Platform Decommissioning Case Study: Proserv Offshore. May 2009

Carr, M., McGinnis M.V., Forrester, G., Harding, J., Raimondi, P. Consequences of Alternative Decommissioning Options to Reef Fish Assemblages and Implications for Decommissioning Policy. OCS Study MMS 2003-53. Oct 2003

Coleman, H. Decommissioning offshore installations: a global problem—a costly solution? Management Report. Executive Summary. 1997. Available: http://www.ftenergy.com/oil/oilrs28.htm

Convention on the Continental Shelf, done at Geneva 29 April 1958; entered into force 10 June 1994 (15 UST 471; TIAS 5578: 499 UNTS 331).

Dauterive, L. Rigs-to-Reefs Policy, Progress, and Perspective. Oct 2000

Decommissioning Activity in the Gulf of Mexico Worth US$3bn Over 5 Year Period. Decomworld. December 2009. Retrieved from http://social.decomworld.com/pr/decommissioning-activity-gulf-mexico-worth-us3bn-over-5-year-period

Dubose, W.P. R.E.E.F task force. In: Proceedings, Fifth Annual Gulf of Mexico Information Transfer Meeting, U.S. Dept. of Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA OCS Study MMS 85-0008. 1985

Ferreira D.F., Suslick S.B. A New Approach for Accessing Offshore Decommissioning: A Decision Model for Performance Bonds. SPE 61219. June 2000

Griffin, W.S. 1999. Evolution of the Global Decommissioning Regulatory Regime. Phillips Petroleum Company. May 1999

Griffin, W.S. Managing the Platform Decommissioning Process. Phillips Petroleum Company, SPE 48892. 1998

Griffin W. S. Regulatory Considerations – International Issues, Proc., Joint Workshop on the Decommissioning of Offshore Oil and Gas Platforms, Jakarta, Indonesia. 1998

Griffin, W.S. Global Perspective on Decommissioning. June 2004

Gorman D.G. and Neilson J. Decommissioning Offshore Structures. 1998

Gram T., Kluge R., Kristensen J.F., Johannessen, Krogh E., Hagemann C. Decommissioning of Frigg and MCP01 – A Contractor View. May 2011

Gudmestad OT, Sparby B.K., and Stead B.L. Reusable Platform Concepts. SPE 25313. February 1993.

Idle Iron NTL: Catch 22 for US regulator? Decomworld. October 2010. Retrieved from http://social.decomworld.com/industry-insight/idle-iron-ntl-catch-22-us-regulator

JPT (Journal of Petroleum Technology). Article on Offshore Heavy Lift and Decommissioning. May 2011

Kaiser M., Mesyanzhinov D. and Pulsipher A. Modeling Structure Removal Processes in the Gulf of Mexico. OCS Study MMS 2005-029. May 2005

Kaiser M., Yu Y., Pulsipher A. Coastal Marine Institute, Assessment of Marginal Production in the Gulf of Mexico and Lost Production from Early Decommissioning. April 2010

Kasprzak R.A., Use of Oil and Gas Platforms as Habitat in Louisiana's Artificial Reef Program, Louisiana Department of Wildlife and Fisheries, Offshore Technology. May 1998.

McGinnins M.V., Fernandez L. & Pomeroy C. The Politics, Economics, and Ecology of Decommissioning Offshore Oil and Gas Structures. March 2001

Mustang Engineering. 2011

National Hurricane Center, NOAA, National Weather Center. 2011

Nichol J.R. and Kariyawasam, S.N. Risk Assessment of Temporarily Abandoned or Shut in Wells. Project 99041. October 2000

Nord Stream AG. Offshore Pipeline through the Baltic Sea – Considerations for Decommissioning. July 2009

Oil Field Diving. Retrieved from Offshore Diver web site: http://www.offshorediver.com/content/

PMB Engineering, Inc. Benchmark Ultimate Strength Analysis - Sample Application of API RP 2A, Section 17. September 1997

Presentation Preserving and expanding the Rigs-to-Reefs program in the Gulf of Mexico

Proserv Offshore. Review of the State of the Art for Removal of GOM US OCS Oil & Gas Facilities in Greater than 400' Water Depth M09PC00004. Oct 2009

Stanley D. and Wilson C. Variation in the density and species composition of fishes associated with three petroleum platforms using dual beam hydroacoustics. Fisheries Research 47. 2000

Tettero, F., Barclay I. Optimizing Integrated Rigless Plug and Abandonment – A 60 wells case study. SPE 89636. March 2004

The Oil Industry International Exploration and Production Forum (E&P Forum). Removal/Disposal of Large North Sea Steel Structures, Report No.10.14/243. July 1995

Thornton W.L. Decommissioning: Review of 1995-1997 and the Global Opportunities. Houston: 8th Annual ASME/API Energy week. 1997

Thornton W. Current Trends and Future Technologies for the Decommissioning of Offshore. Offshore Technology Conference. May 2000

Towmey B. Study Assesses Asia-Pacific Offshore Decommissioning Costs. Oil and Gas Journal. 2010.

United Nations Convention on the Law of the Sea, UN Doc. A/CONF. 62/122 reprinted in Z1 I.L.M. 1261. 1982

Versabar. 2011. Retrieved from http://www.vbar.com/

Watson T. Re-Use and Disposal Considerations, Amoco Exploration Company Proc. Joint Workshop on Decommissioning of Offshore Oil and Gas Platform, Jakarta, Indonesia. 1998

Wisch D.J., Puskar F.J., Laurendine T.T., O'Connor P.E., Versowsky, P.E. and Bucknell J. An Update on API RP 2A Section 17 for the Assessment of Existing Platforms. OTC 16820. May 2004

World Bank Multistakeholder Initiative. Towards Sustainable Decommissioning and Closure of Oil Fields and Mines: A Toolkit to Assist Government Agencies. Version 3.0. March 2010.

Wright C. International Petroleum Accounting

The Oil Industry International Exploration and Production Forum (E&P Forum) (1995), Removal/Disposal of Large North Sea Steel Structures, Report No.10.14/243, July

Vita

Sandra Milena Wiegand was born in Colombia. She attended Santa Dorotea High School in Cali and graduated as valedictorian in 1993. In Fall of 1993, she was admitted to the Universidad Surcolombiana in Neiva, Colombia. She received her Bachelor of Science in Petroleum Engineering in March 2000. While at the Universidad Surcolombiana she was granted a scholarship, and, consequently, she became an exchange student at the University of Oklahoma during 1998-1999, where she obtained her Certificate in Petroleum Engineering. In August 2009, while maintaining her full-time employment, she entered the Graduate School at the University of Texas in Austin.

The author can be reached at: sandra_wiegand@yahoo.com

This thesis was typed by the author.